


## Imaging Cervical Spine Trauma



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## Overview, Objectives

<h3>Technical Factors</h3> <p>Proper technique Computed Radiology (CR) Digital Radiology (DR)</p> <p>Projections obtained How, why</p>	<h3>Imaging Indications</h3> <p>Plain CR CT MRI Protocolization Radiologic Triage</p>
<h3>Select Trauma Cases</h3> <p>History, images, plain film findings, CT PRN Each case followed by diagnosis slide with notes Cases from S+T, WR, NNMCM, War, MedPix Penetrating trauma, IED, blast</p>	<h3>Summary</h3> <p>Interactive ARS quiz cases  Questions References</p>

## Trauma

- Major Public Health problem
  - Often preventable
- Accidental trauma:
  - MVA, occupational (i.e. war)
- Non-accidental trauma
  - i.e. assault, SCAN



## "Reasonably prudent person"

**Lectric Law Dictionary:** <http://www.lectlaw.com/def2/q017.htm>

*"The model of all legal behavior. This person does everything in moderation, follows the community ethic, and always exercises due care. You will find very few of these people in either the Business or Medical Schools."*

**Bar Review tapes:**

- Friend goes to squirt lighter fluid on lit BBQ
  - Reasonably prudent person says:
  - "I wouldn't do that"

## Technical Factors CR, DR

**Patient information.**  
Confirm name, date, social security number or pt ID #.

**Position. Adequacy of study.**  
Entire area in question covered  
i.e. base of skull to C7-T1 interspace (30% of injuries include C7)  
Check position markers (right or left).

**Projections: cross-table lateral, AP and open-mouth**  
Swimmers when C7- T1 not seen on lateral (40%)

## Cervical Spine Trauma Protocolization


**Cross-table lateral**

**Additional views: AP, open mouth,**  
Swimmers (when cannot see C7-T1)  
Obliques, flexion-extension  
Entire spine (with any fracture of spine)

**CT:**  
Axial, sagittal and coronal reformats, 3D

**MRI C-spine**  
Neurologic deficit referable to C Spine:  
Surgical subspecialty consultation and MRI and C-spine

**Note: CT and/or MRI are not always available**



## Cervical Spine Specific Rules

Routine: Lateral, AP, Open-mouth. Swimmers PRN  
COUNT VERTEBRAE  
**ALWAYS CLEAR C7 AND T1 INTERSPACE!**

Obtain multiple and extra views when needed.

Responsible for everything on the exposure  
Even non-cervical spine things, always true

Patients with fractures or dislocation of the cervical spine should have the entire spine examined when stabilized  
4% to 5% of patients have multiple noncontiguous lesions  
*Obtain CT Scan in difficult cases*

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## CT of Cervical Spine

Superior contrast resolution  
Better to evaluate spinal cord injury  
Spinal canal evaluation:

Bone, disc, foreign bodies, blood can be identified  
Coronal and sagittal reformations often helpful  
Faster, requires less patient manipulation/ cooperation  
Cost-effective to perform in *high-risk* patients  
Multiple-trauma patients with altered mental status  
or those who are uncooperative



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## Indications for CT

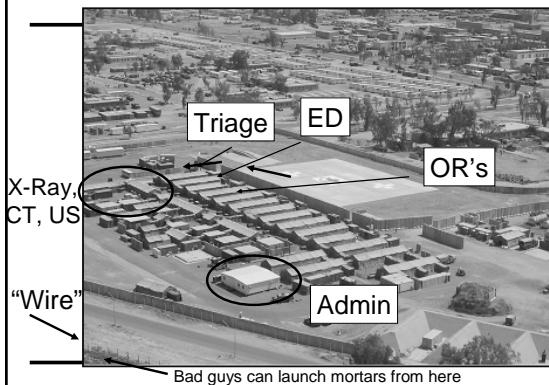
Hospital specific based on equipment, proximity to ED  
When getting a head CT for trauma:

Include craniocervical junction  
Consider inclusion of all of C-spine  
High incidence of upper cervical fractures associated with head trauma

Nonvisualization C7-T1 on lateral or swimmers  
Directed examination through a specific area of known or suspected injury.  
When plain films are inconclusive of clinically suspected injury

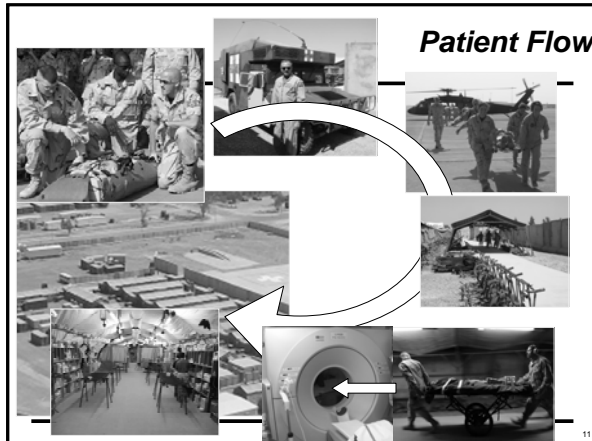
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## Big Picture: EMEDS Footprint



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## Patient Flow



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## ARFD: Advanced Radiologic Field Diagnostics (not)



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## Acute Trauma: MR Indications

Plain images normal but patient has a neurologic deficit possibly caused by cervical spinal cord or root injury

MR obtained with the immobilization device left in place.

Very sensitive for soft tissue injuries

Ligamentous injuries and post-traumatic lesions causing compression of the spinal cord or nerve roots such as disc herniation or hemorrhage.

**Most sensitive for detection of intrinsic spinal cord pathology**



## MRI in Acute C-Spine Trauma

STIR or T2 fat-saturated images should always be obtained to distinguish between normal fat and soft tissue edema, which will frequently be detected at the sites of radiographically-occult ligamentous injuries.

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## Major Injuries: Mechanism

### 1. Hyperflexion

- a. Hyperflexion sprain
- b. Hyperflexion dislocation
- (1) Without facet lock
- (2) With unilateral or bilateral facet lock
- c. Comminuted ("teardrop") body fracture
- d. Burst fracture
- e. Hyperflexion fracture-dislocation
- f. Occipito-atlantal dislocation/subluxation
- g. Atlantoaxial dislocation
- h. Anterior fracture-dislocation of dens
- i. Lateral fracture-dislocation of dens

### 2. Hyperextension

- a. Hanged man fracture
- b. Hyperextension sprain
- c. Posterior fracture-dislocation of dens
- d. Posterior atlantoaxial dislocation
- 3. Rotary
- a. Rotary atlantoaxial dislocation (fixation)
- b. Rotary atlantoaxial subluxation
- 4. Axial compression
- a. Bursting fracture of Jefferson
- b. Vertical and oblique fractures of axis body
- c. Occipital condyle type III fracture

Daffner RH, Brown RR, Goldberg AL. A new classification for cervical vertebral injuries: influence of CT. *Skeletal Radiol*. 2000 Mar;29(3):125-32.

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## Major Injuries: Mechanism

### 1. Hyperflexion

- a. Spinous process fracture
- b. Wedge-like compression of body
- c. Transverse process fracture (isolated)
- d. Uncinate process fracture (isolated)
- e. Articular pillar fracture (isolated)
- f. Laminar fracture
- g. Lateral wedge fracture body

### 2. Hyperextension

- a. Horizontal fracture of anterior arch of atlas
- b. Anterior inferior margin of C2 ("teardrop")
- c. Spinous process fracture
- d. Posterior arch of atlas fracture (isolated)
- 3. Rotary
- None
- 4. Axial compression
- a. Lateral mass of atlas (isolated)
- b. Occipital condyle type I and type II fractures

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## Classification, Stability of Injury

### Major and Minor

#### Stable spinal injury:

Movement of the patient causes minimal or no risk of producing or aggravating neural injury.

#### Unstable spinal injury:

Spinal canal is unable to maintain normal relationships under physiologic conditions. (White)

#### Example major (unstable) injuries:

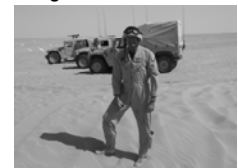
- Bilateral locked/jumped facets
- Flexion teardrop fracture

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## \*(ABCDE'S)<sup>2</sup> in MSK Imaging

- A = Anatomic appearance
- B = Bone Density
- C = Cartilage (joint, disk spaces)
- D = Distribution
- E = Erosions
- S = Soft tissues

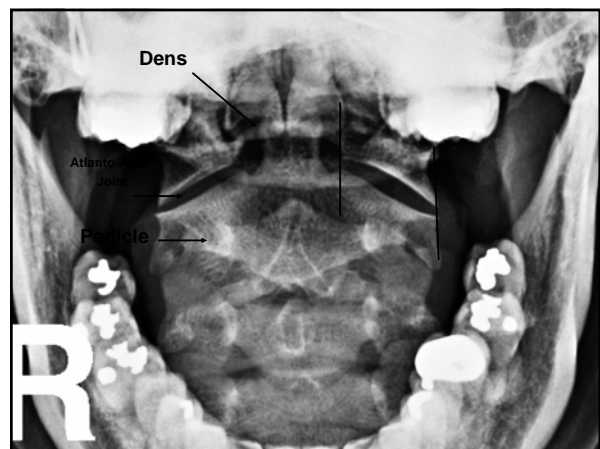
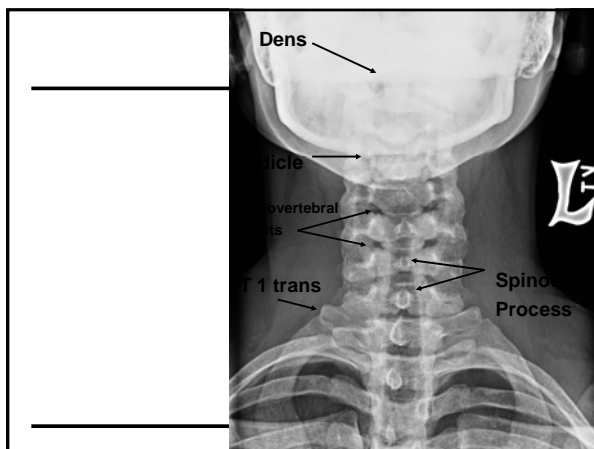
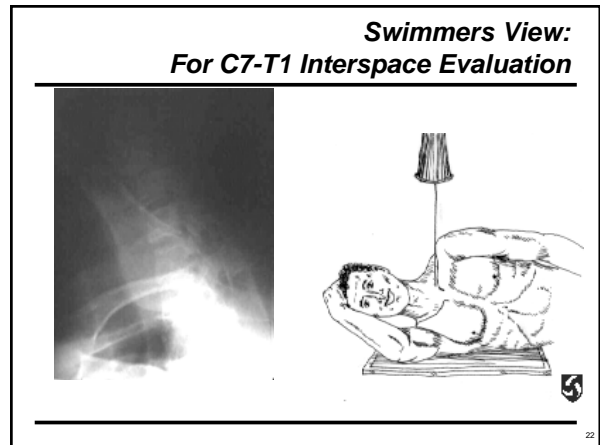
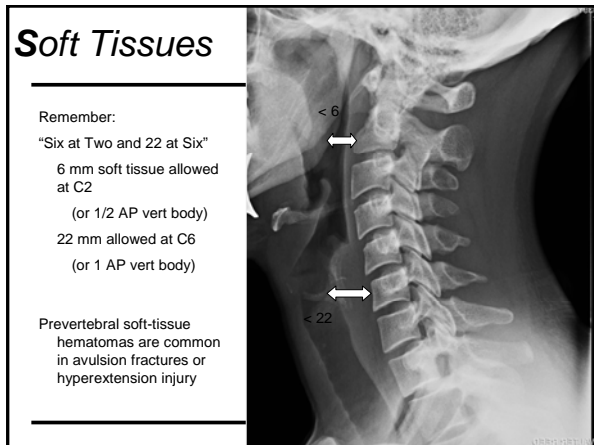
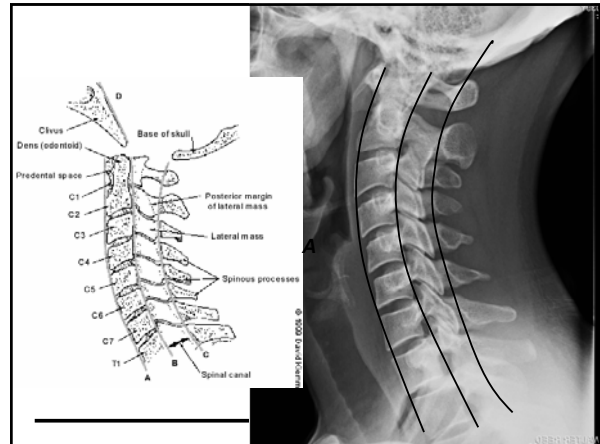
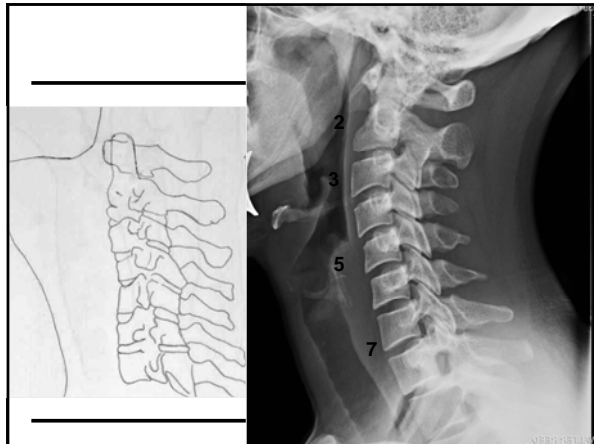
- A = Alignment, Asymmetry
- B = Bone mineralization
- C = Contours, Characteristics
- D = Deformity (trauma, acquired)
- E = Extent
- S = Swelling



MedPix Factoid 6900:

<http://rad.usuhs.mil/medpix/medpix.html?mode=single&recnum=6900>

Approach



### ***First case***

28 AD male run over  
by ATV in Northern  
Iraq (Desert Storm)



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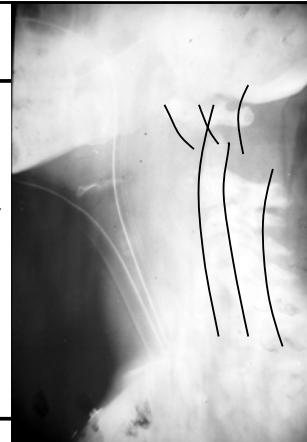
### ***Atlanto-axial dislocation***

Note alignment  
completely off at C1-C2  
Note severe STS anterior  
to vert bodies

NG tube, ET tube  
displaced anterior

Clinical: DOA

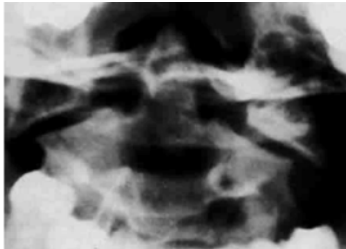
Not compatible with  
life



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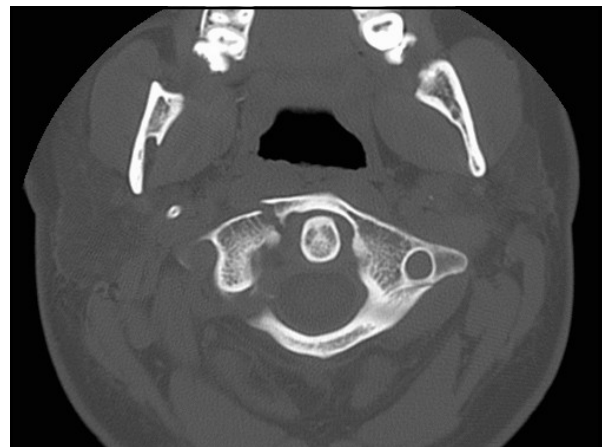
### ***History***

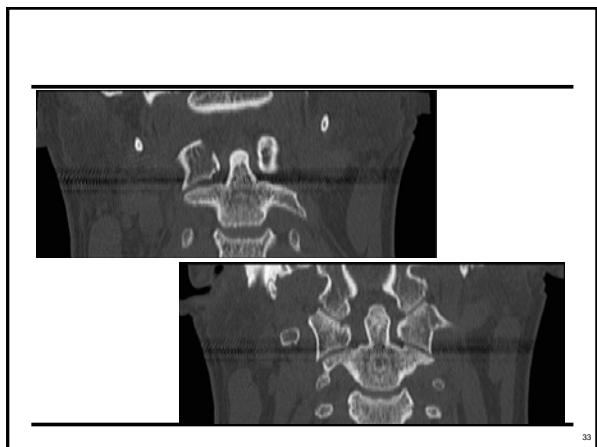
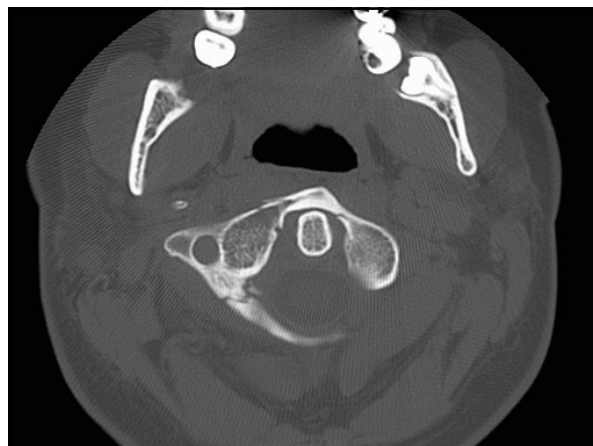
27 year old F involved in high speed MVA



Presented to ED with GCS of 12, no focal neurologic findings  
Multiple abrasions and minor lacerations on all extremities and the face.

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### *Multiple C1 fractures*

Selected axial CT images in bone windows show multiple fractures of C1 including bilateral anteriolateral fractures with no displacement of left lateral mass and moderate displacement of the right lateral mass best visualized on the coronal reformatted images.

There is also a comminuted fracture in the right posteriolateral portion of the C1 ring with a small, triangular fragment abutting, but not compromising the thecal sac.

Patient stabilized with Halo for three months.

MedPix Case Summary: 7401

### *History*

38 y.o. male s/p MVA

Cervical spine  
subluxation  
C2 on C3

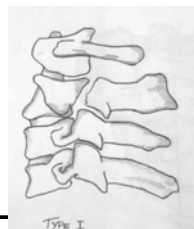
**Findings:**  
Anterior  
subluxation of  
C2 on C3

Prevertebral  
Soft tissue  
swelling



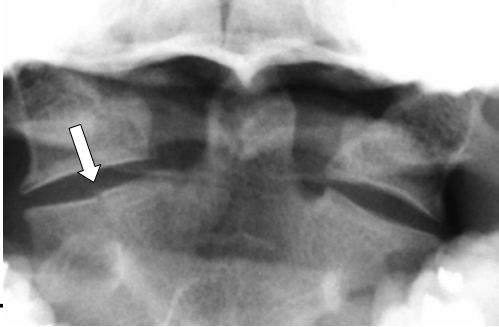
*History would give it away*

Hangman's fracture  
Or "Hanged Man"  
Fractures through the pedicles of  
C-2  
Traumatic spondylolysis of  
the axis



## History

25 y.o. male s/p MVA with Neck pain



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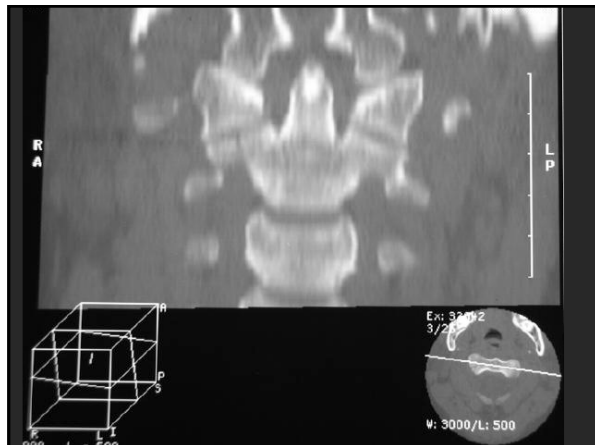
## Fracture of C2 (Axis) right transverse Process

Linear lucency along the right transverse Process confirmed on CT as a Fracture.

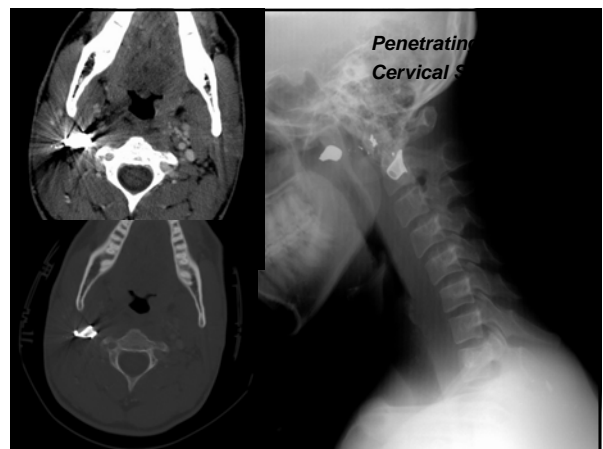
Four types of Axis fractures:

avulsion, transverse, burst, and sagittal fractures

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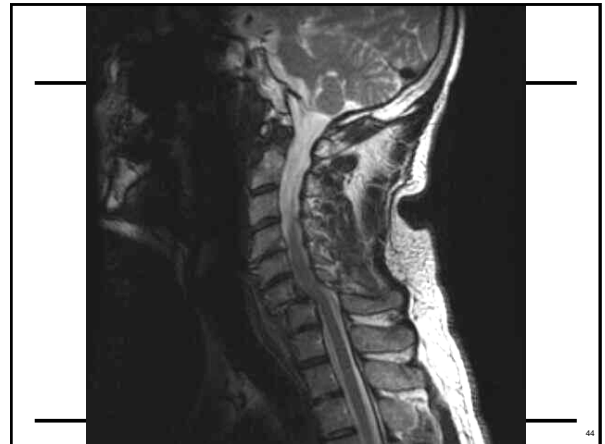
Extension teardrop fracture  
Secondary to a hyperextension mechanism  
Potentially unstable



## History

Dove into pool that was not completely filled

Hyperflexion injury, stabilized on backboard



## Bilateral Jumped Facets

Lateral cervical spine radiograph shows anterior dislocation of the C6 vertebral body by greater than 50% of the AP vertebral body diameter

Interlocking of the C6 and C7 facets, and without evidence of significant rotation  
There is no evidence of fractures.

ACR Code: 4 . 4 - Lateral : XR - Plain Film

*His pool was half-empty*

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## MR jumped facets

FIGURE 2: A midline sagittal T2 FRFSE MR image through the cervical spine shows marked spinal canal stenosis at the level of the bilateral facet dislocations, without evidence of abnormal spinal cord signal.

When imaging cases of acute C-spine trauma with MRI, STIR or T2 fat-saturated images should always be obtained to distinguish between normal fat and soft tissue edema, which will frequently be detected at the sites of radiographically-occult ligamentous injuries.

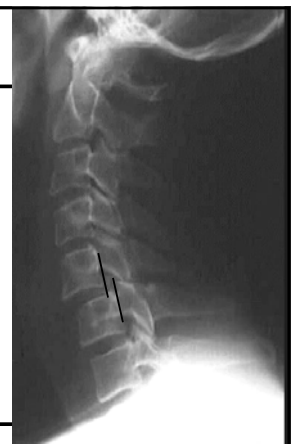
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Another Bilateral facet dislocation, this one better demonstrating "naked facet"

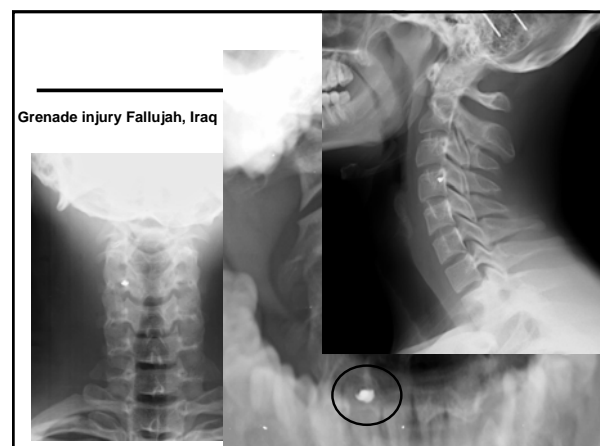
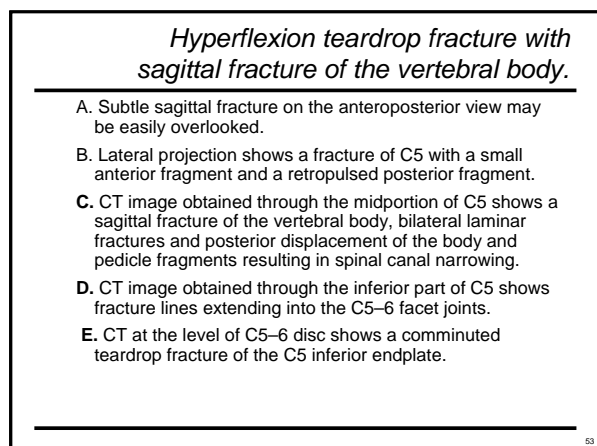
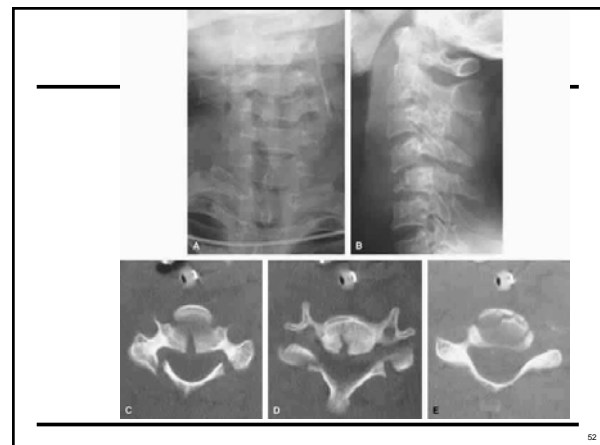
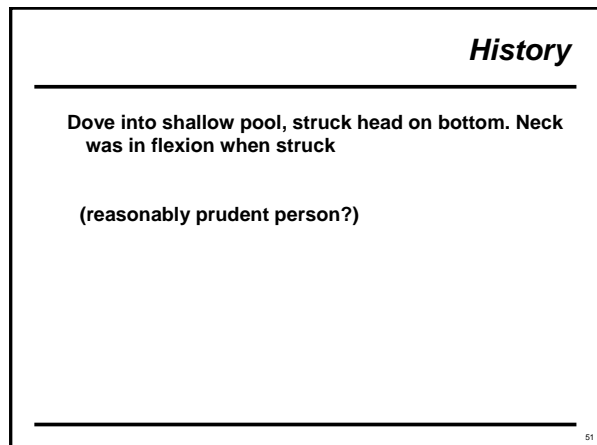
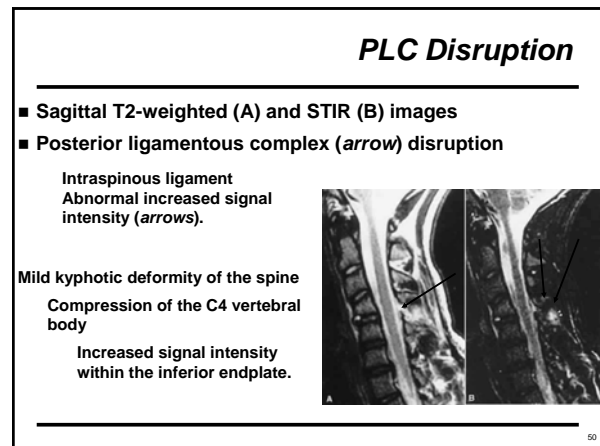
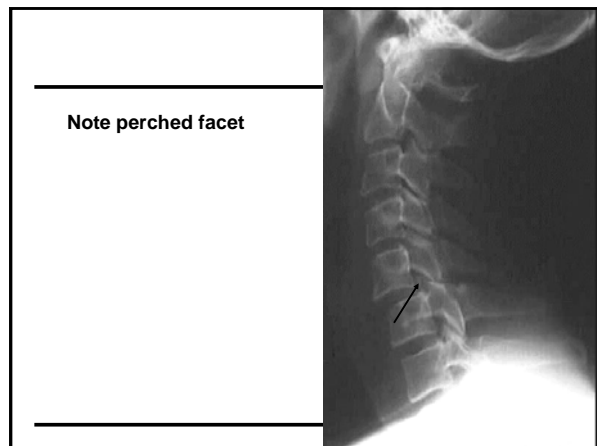
Tx: Supportive  
High dose steroids  
Halo

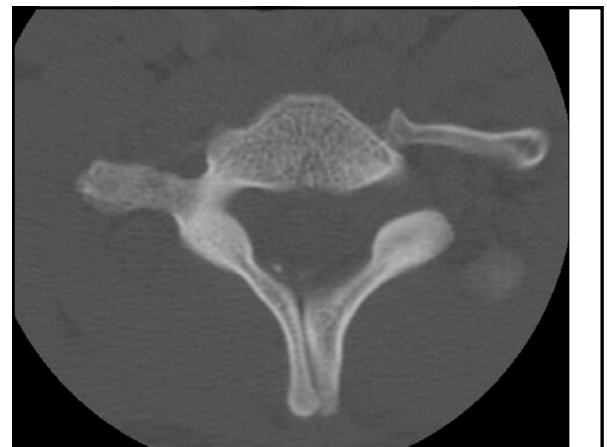
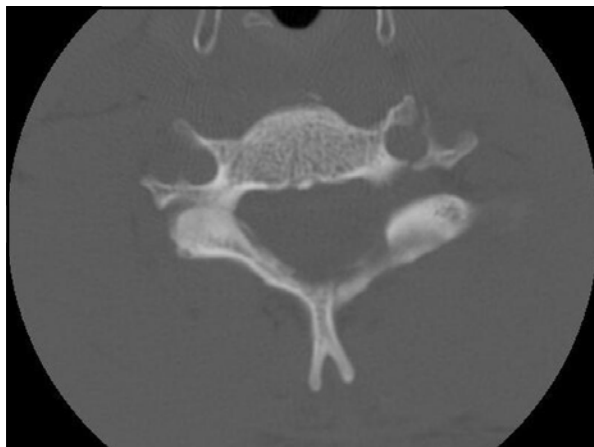
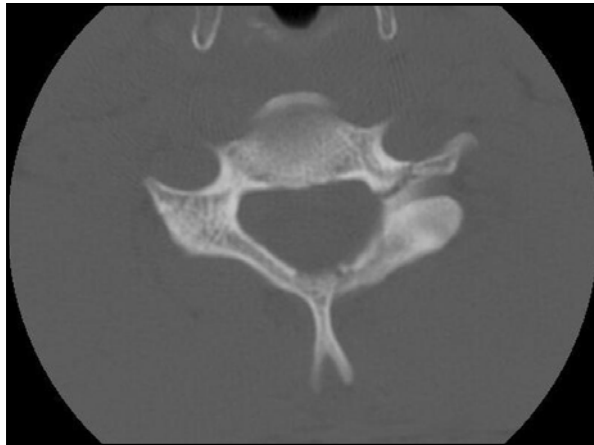
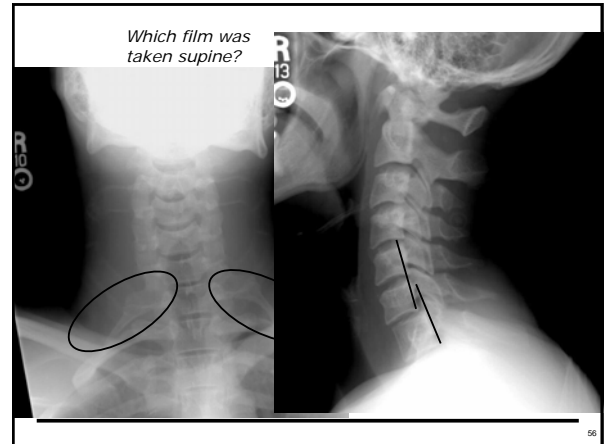
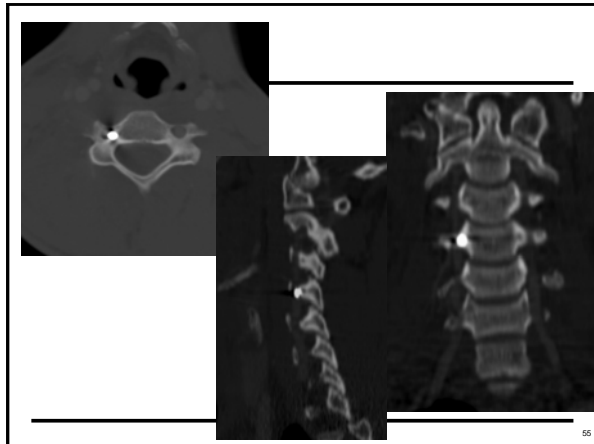


Unilateral facet dislocation









## *Left Pedicle fracture*

**C6 left pedicle and laminar fractures with anterior subluxation of C6 on C7**

**Findings: Plain film C-Spine findings: slight anterior subluxation of C6 on C7.**

This injury is considered stable because the pedicle and lamina of only one side are disrupted, the other intact side preventing any further anterior subluxation of the C-6 vertebra and subsequent spinal canal narrowing.

Treatment: Cervical spine fracture treatment is based upon neurological findings and stability of the injury. Since the injury is considered stable, treatment consists of neck stabilization with a cervical neck collar.

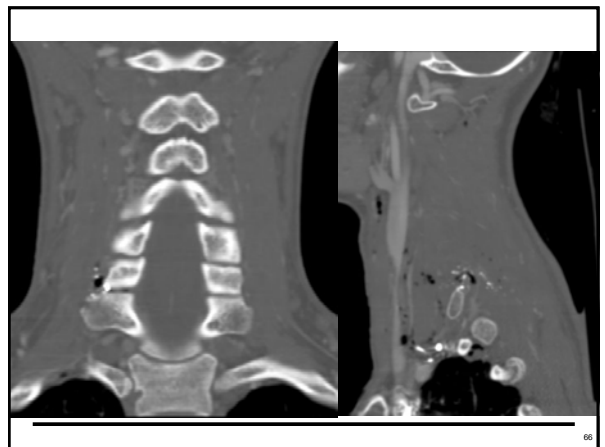
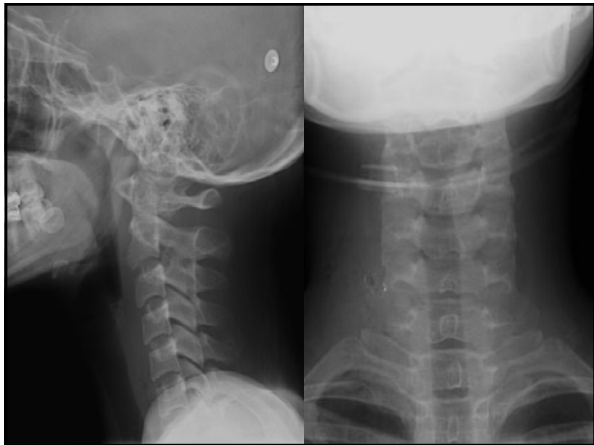
Surgical intervention unnecessary in this patient with a stable cervical spine fracture.

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## *History*

**Shot in neck, rule out fracture, asses vascular and spinal cord involvement**

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## Findings

Retained bullet fragments and subq emphysema demonstrating tract

No CT evidence of vascular compromise  
Angio confirmed

Should have # of bullets / entrance and exit wounds  
Explain??

- 1 entrance wound plus 1 exit wound or
- 1 entrance wound plus 1 bullet found or
- 2 entrance wounds plus 1 exit plus 1 bullet, etc.

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## History

Working on autobahn in Germany:

Sudden neck pain after shoveling clay (stuck to shovel when over his back)

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## Clay-shoveler's fx

This oblique or vertical fracture of the spinous process of C-6 or C-7 is caused by an acute powerful flexion, such as that produced by shoveling.

Deriving its name from its common occurrence in Australian clayminers in the 1930s, clay-shoveler's was simultaneously labeled with the same name in Germany, where it was seen among workers building the Autobahn.

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## Summary

Systematic approach to films: ABCDS

Any checklist to make sure everything covered  
STS, other clues (history, old films)

Responsible for all 7 (unless sloth) vertebrae  
And interspaces

Swimmers and/ or CT if needed

Responsible for everything on the film, don't fixate  
Sella, facial structures, soft tissues, etc.

Don't be a pain in the neck, find the abnormality

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